Chapter 20-Light

The Nature of Light

1. Visible Light Is a Form of Electromagnetic Radiation
   1. Radiation=movement of energy from one place to another
      1. Particle radiation, mechanical radiation, electromagnetic radiation
   2. Electromagnetic radiation is classified by amount of energy being moved. Electromagnetic spectrum includes radio waves, microwaves, infrared rays, visible light, ultraviolet rays, X-rays, and gamma rays
      1. Long wavelengths and low frequencies, short wavelengths and high frequencies
      2. Electromagnetic…
         1. …waves are invisible to human eye (exception visible light)
         2. …radiation =electric and magnetic fields
         3. …radiation travels through a vacuum as easily as air (some solids and liquids also)
2. Electromagnetic Waves (EW) Travel at the Same Speed but Differ in Wavelength and in Frequency
   1. Speed= 299,743 kps
   2. Wavelength=distance between corresponding parts of two waves with the same motion
   3. Frequency= number of waves that pass by a point in a specified amount of time, such as one second
      1. EW with long wavelengths (radio waves)= low frequencies, EW with short wavelength (X-rays)= high frequencies
      2. Shorter wavelength=greater energy=higher frequency
      3. Cycle=one complete up-and-down movement of a wave (1 second=60 complete waves pass a given point)
      4. Kilocycles/hertz(thousands of cycles), megacycles/hertz (millions of cycles), 1hertz=1 cycle
   4. Speed=wavelength times frequency
3. Waves with Long Wavelengths and Low Frequencies
   1. Infrared rays=band of invisible waves that we perceive as heat
   2. Microwaves=high energy waves that are close in frequency to the infrared band produced by masers (microwaves amplification by stimulated emission of radiation)
   3. Radio waves make up a wide band of invisible rays that are found below the infrared rays, longer wavelengths than infrared
4. Waves with Short Wavelengths and High Frequencies
   1. Ultraviolet (UV) rays, X-rays, gamma rays
      1. UV rays=first band of rays beyond visible blue light rays
      2. UV radiation comes from the sun, needed for vitamin D production
      3. X-rays constitute a band of waves found beyond the UV rays (shorter wavelength and higher frequency)
      4. Gamma rays=high-energy electromagnetic waves found beyond the the band of X-rays

Visible Light

1. Magnetic Characteristic
   1. Scientists do not fully understand the exact nature of electromagnetic waves
      1. Know: although light travels in waves it has certain behaviors that are explained by assuming that light acts like a particle
      2. Photons=particles/packets of energy
      3. Zeeman effect
2. Light Travels in Straight Lines
   1. Light always travels in straight lines
      1. Ray=thin line of light
      2. Beam=light made up of many rays
   2. Light travels at 299,743 kps
   3. Light is a unit for measuring great distances (distance in the solar system)
3. Transport, Translucent, and Opaque Materials
   1. Light can pass through certain material not is stopped by others
      1. Transparent=air, plastic wrap, water and clear glass
      2. Translucent=frosted glass, some plastics
      3. Opaque=cannot see through it, no light passes through
   2. Shadows are formed when opaque material is placed in the path of rays of light
4. Sources of Light
   1. Luminous=material that emit light
   2. Sun is a natural source of light and chief source
   3. Stars are natural source of light
   4. Moon and planets do not produce their own light
   5. Bioluminescence= biochemical process where organisms can produce their own light
   6. Artificial sources of light include candle, kerosene lamp, gasoline lamp, electric light, fluorescent light, neon light, sulfur lamp, laser light
   7. Sulfur lamp=uses microwave energy on sulfur gas to create a bright, cool, energy-efficient source of light
   8. Laser light=does not spread out as do other forms of light energy but travels in a narrow beam that spreads very little
      1. Light Amplification Stimulated Emission of Radiation
5. Measurement of Light
   1. Candles=measurement of intensity of a light source
   2. Footcandles=intensity of illumination measure in ft
   3. Luminous flux-unit of light power
   4. Lumens=what luminous flux is measured in
   5. Photometer=used to emasure the amount of light given off by a source

The Reflection of Light

1. Light Can Be Reflected
   1. To enable us to see an object 3 things must happen
      1. Must be a source of light
      2. Light must strike the object
      3. Light must be reflected from the object and travel to the eye
   2. Reflected light changes directions but always travels in straight lines
   3. Transparent and translucent materials allow most of the light to pass through
   4. Opaque material do not allow any light to pass
2. Law of Reflection
   1. When a ray of light strikes a mirror perpendicular to the surface of the mirror, the ray is reflected directly back
   2. When a ray of light strikes a mirror at a slant, or angle, the ray is reflected at a slant/angle
      1. Incident=the ray that strikes the mirror
      2. Reflected ray=ray that is reflected by the mirror
      3. Angle of incidence=angle between the ray of light that strikes the surface and the normal
      4. Angle of reflection=angle between the reflected ray and the normal
      5. The law/principle or reflection state that the angle of incidence is equal to the angle of reflection
   3. Law of reflection is true for all smooth polished surfaces
3. Mirrors
   1. Flat, plane, curved
   2. Flat mirror=made of a flat piece of clear glass
      1. Image=reflected of objects
   3. Curved mirror=curved inwards or outward
      1. Concave mirrors=mirrors that curve inward
      2. Convex mirrors=mirrors that curve outward

The Refraction of Light

1. The Nature of Refraction
   1. When light rays strike a transparent material at 90˚, they travel in a straight line and slow down
   2. Refracted=when light rays pass at a slant (angle) from one transparent material into another transparent material (air to water), they travel in a different direction
      1. Still travel in a straight line
      2. If they pass from one material into another in a perpendicular line, there is no refraction
   3. Light is bent because there is a change in the speed of the light as it passes from one transparent material to another
      1. Optical density=the difference in speed depends on optical density
2. Lenses
   1. Lens is a piece of transparent material (glass) that is curved on one side and flat on the other
      1. Used to bend, refract light rays
   2. Lenses are curved either inward (concave) or outward (convex)
   3. Convex lens=thicker in the middle
      1. Focal point=the point at which the rays meet
      2. Real image=convex lens is placed between an object and a screen, an inverted, or upside down, image can be formed on the screen
      3. Virtual image=convex lens is placed between your eyes and an object, the object appears larger, image is larger than the object is formed
   4. Concave lens=thicker in the middle than at the edges
      1. Concave image only produces a virtual image
   5. Lenses are used in many kinds of instruments
      1. Camera=parts of a camera are lightproof box, opening in front of the camera, shutter over the opening, convex lens behind the opening, film at the back of the camera, device to hold and turn the film
      2. Light microscope= two convex lenses one at each end of a lightproof tube
      3. Telescopes=reflecting telescopes (large concave mirror at one end and a small convex lens at the other that magnifies the image produced by the mirror) and refracting telescopes (large convex lens in the object collects all the light from a distant object and bends the light rays to produce an image, which is magnified by the smaller convex lens
      4. Binoculars=two refracting telescopes connected side-by-side
      5. Projectors=one or more convex lenses to project an enlarged image onto a screen

Color

1. The Spectrum
   1. Prism=a narrow beam of sunlight passes at a slant into a triangular transparent material
   2. Spectrum=sunlight separated into a band of colored lights
      1. Rainbow=dispersion (separation of sunlight into its component colors) can be seen in a rainbow
2. Primary and Complementary Colors
   1. A colored light is only a part of a white light
   2. Primary additive colors=red, green blue
   3. Complementary colors=any two colors mixed together
3. Colored Materials
   1. A material looks a certain color because when white light strikes the material some colors are absorbed and others are reflected to the eye
   2. Primary colors of paints=cyan, yellow, magenta (subtractive colors)
4. The Colors of the Sky and the Sun
   1. During the day the sky appears blue and the Sun appears yellow, this is caused by the presence of dust